Serial No. 10/063,962
Docket No. 13DV-13657

REMARKS

In the Office Action, the Examiner reviewed claims 1-20 of the above-identified US Patent Application, with the result that claims 1, 3, 4, 14 and 15 were rejected under the judicially-created doctrine of double patenting in view of claims 1 and 2 of U.S. Patent Application Serial No. 09/833,446 (now U.S. Patent No. 6,586,115) to Rigney et al. (Rigney), claims 1, 2, 5, 6, 9-14, 16 and 18-20 were rejected under 35 USC §102 as being anticipated by U.S. Patent No. 6,025,078 to Rickerby et al. (Rickerby), and claims 1, 2, 7-11, 13, 14, 17, 18 and 20 were rejected under 35 USC §103 as being unpatentable over U.S. Patent No. 4,579,874 to Spengler et al. (Spengler) in view of U.S. Patent No. 4,886,768 to Tien. In response, Applicants have amended the claims as set forth above. More particularly:

The specification has been amended to update the status of the Rigney patent.

Independent claims 1 and 14 have been amended to limit the amount of neodymia to 4 weight percent instead of "about 5 weight percent," and claim 14 has been further amended to limit the amount of lanthana to 4 weight percent instead of "about 5 weight percent." Support for these amendments can be found in Applicant's specification at paragraph [0021].

Dependent claims 4 and 15 have been amended to limit the amount of lanthana to about 1 weight percent, and dependent claims 6 and 16 have been amended

to limit the amount of neodymia to about 0.6 weight percent. Support for these amendments can also be found in Applicant's specification at paragraph [0021].

Applicants believe that the above amendments do not present new matter. Favorable reconsideration and allowance of claims 1-20 are respectfully requested in view of the above amendments and the following remarks.

Rejection under Obviousness-type Double Patenting

The rejection under the judicially-created doctrine of double patenting is on the basis that Rigney discloses a thermal barrier coating consisting essentially of zirconia partially stabilized by up to 3 weight percent yttria and to which is alloyed at least one additional metal oxide that may be lanthana.

Applicant hereby acknowledges that the present application and Rigney are commonly assigned.

Applicant requests that the double patenting rejection be held in abeyance until allowable subject matter has been indicated by the Examiner. At that time, a terminal disclaimer pursuant to 37 CFR §1.321(b) will be submitted which terminally disclaims that portion of the patent issuing from the present patent application which extends beyond the termination date of Rigney.

Rejection under 35 USC §102

Independent claims 1 and 14 and their dependent claims 2, 5, 6, 9-13, 16 and 18-20 were rejected as being anticipated by Rickerby on the basis that Rickerby discloses a thermal barrier coating comprising zirconia, 4-20 weight percent yttria, and 4-25 weight percent neodymia. Actually, Rickerby discloses the use of 5-25 weight percent neodymia (or 4-25 *molar* percent neodymia). See column 4, lines 42-48. Rickerby states that "[a]ny suitable amount of the second oxide [e.g., neodymia] may be used, for example it may be possible to use more than 25 wt % and less than 5 wt % and still obtain a reduction in thermal conductivity of the ceramic thermal barrier coating." However, what might by an acceptable lower amount of neodymia is not disclosed or explained.

As now amended, Applicant's amended independent claims 1 and 14 limit the amount of neodymia to 4 weight percent. Therefore, Applicant believes that claims 1 and 14 are not anticipated by Rickerby, and respectfully requests withdrawal of the rejection under 35 USC §102. Applicant further believes that the upper limit of 4 weight percent is sufficiently different (20% lower than the lower limit taught by Rickerby) to be patentably distinguishable from Rickerby under 35 USC §103.

Rejection under 35 USC §103

Independent claims 1 and 14 and their dependent claims 2, 7-11, 13, 17, 18 and 20 were rejected as being obvious over Spengler in view of Tien on the basis that Spengler discloses a turbine engine blade, a bond coat on the blade, and a ceramic coating of yttria-stabilized zirconia (YSZ) on the bond coat. The Examiner noted that Spengler does not teach additional materials for use as the ceramic coating, but then cited Tien as teaching an yttria-stabilized zirconia toughened with additions of 0.5 to 1.5 molar % tantala (which Applicant calculates to be an equivalent range of about 2 to about 10 weight %). The Examiner acknowledged that Tien "does not teach application of the stabilized zirconia to a substrate, but does contemplate its use as a coating," and concluded that one skilled in the art would have used Tien's material in place of the stabilized zirconia layer of Spengler to provide a coating "with improved impact resistance and increased fracture toughness."

The reference made by Tien to coating materials is in the "Description of the Prior Art" - whether Tien's material was contemplated as being suitable as a coating material is not clear from Tien's teachings. Tien states that "[t]he ceramics of the present invention include broadly the stabilized or partially stabilized zirconias that categorically involve tetragonal zirconia polycrystals, TZP." TZP is a term generally made in reference to toughened structural zirconia-based ceramics stabilized in the tetragonal phase by, e.g., yttria. The attached excerpt from the NIST Web site lists

TZP's as being in the form of sintered or sintered and hipped. Consistent with this definition, Tien's disclosed TZP's are formed of powders that are compacted and sintered (column 3, lines 62-63; column 4, lines 23-32). Therefore, Tien does not teach or disclose tantala as being uniformly incorporated atom-by-atom throughout a zirconia material (as required by Applicant's claims), but instead discloses a mixture of powders that are compacted and sintered together.

From the above, Applicant believes that, by itself, Tien does not teach or suggest that adding tantala to an yttria-stabilized zirconia would yield a composition that is suitable for use as a thermal barrier coating, whose microstructure (e.g., the columnar grains recited in Applicant's claim 14) and other properties are necessarily different from that of a sintered structural ceramic. Stated another way, Applicant does not believe that one skilled in the art would look to the teachings of Tien when considering a thermal barrier coating, in view of the fact that Tien's zirconia material is sintered, presumably has low porosity, and otherwise is not intended as a thermal barrier coating.

In view of the above, Applicant believes that one skilled in the art would not modify Spengler's YSZ coating on the basis of Tien, since these patents are directed to different types of ceramic materials (porous vs. sintered-nonporous).

For all of the above reasons, Applicant respectfully requests withdrawal of the rejection under 35 USC §103.

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Closing

Applicant believes that the claims define patentable novelty over all the references, alone or in combination, of record. It is therefore respectfully requested that this patent application be given favorable reconsideration.

Should the Examiner have any questions with respect to any matter now of record, Applicant's representative may be reached at (219) 462-4999.

Respectfully submitted,

By 
Domenica N.S. Hartman
Reg. No. 32,701

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Hartman & Hartman, P.C.
Valparaiso, Indiana 46383
TEL.: (219) 462-4999
FAX: (219) 464-1166

Attachment: NIST Web page

Zirconia (TZP) (ZrO_2)

Reference: NIST Technical Note

Reference: NIST Structural Ceramics Database

Note: About Property Data Summaries.

Note: Abbreviations and Other Notes

Note: Other Materials

Material Summary:

	[Ref. 1-5]	[Ref. 6-8]	[Ref. 9]
Manufacturer.....:	In laboratory	In laboratory	Toyo Soda Manf. Co.
Material Designation:	zirconia (TZP)	zirconia (TZP)	zirconia (TZP)
Material Form.....:	polycrystal	polycrystal	polycrystal
Composition.....: (mole fraction)	$ZrO_2 \cdot xY_2O_3$	$ZrO_2 \cdot xCeO_2$	$ZrO_2 \cdot$ 3% Y_2O_3
Processing.....:	Sintered	Sintered	Sintered and post-hipped

References:

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[2] G.D. Quinn, R.J. Gettings, and J.J. Kubler, "Fracture Toughness by the Surface Crack in Flexure (SCF) Method: Results of the VAMAS Round Robin," Ceramic Engineering and Science Proceedings, Vol. 15, pp. 846-855 (1994).
[3] J. Wang, W.M. Rainforth, T. Wadsworth, and R. Stevens, "The Effects of Notch Width on the SENB Toughness for Oxide Ceramics," Journal of the European Ceramic Society, Vol. 10, pp. 21-31 (1992).
[4] G.A. Gogotsi, A.V. Drozdov, V.P. Zavata, and M.V. Swain, "Comparison of the Mechanical Behaviour of Zirconia Partially Stabilized with Yttria and Magnesia," Journal of the Australasian Ceramic Society, Vol. 27, pp. 37-49 (1991).
[5] G.A. Gogotsi, E.E. Lomonova, and V.G. Pejchev, "Strength and Fracture Toughness of Zirconia Crystals," Journal of the European Ceramic Society,

Vol. 11, pp. 123-132 (1993).
[6] S. Maschio, O. Sbaizero and S. Meriani, "Mechanical Properties in the Ceria-Zirconia System," Journal of the European Ceramic Society, Vol. 9, pp. 127-132 (1992).
[7] K. Tsukuma and M. Shimada, "Strength, Fracture Toughness and Vickers Hardness of CeO_2-Stabilized Tetragonal ZrO_2 Polycrystals (Ce-TZP)," Journal of Materials Science, Vol. 20, pp. 1178-1184 (1985).
[8] K. Tsukuma, "Mechanical Properties and Thermal Stability of CeO_2 Containing Tetragonal Zirconia Polycrystals," American Ceramic Society Bulletin, Vol. 65, pp. 1386-1389 (1986).
[9] J. Kubler, "Fracture Toughness of Ceramics Using the SEVNB Method: Preliminary Results," Ceramic Engineering and Science Proceedings, Vol. 18 (4), pp. 155-162 (1997).

Property Table:

Temperature = 23 °C

Grain Size [μm]	Porosity [%]	Fracture Toughness [MPa·m$^{1/2}$]	Fracture Energy [J/m^2]	Measurement Method	Measurement Environment	Comments
		11.6		NDC	air	Ref. 1; 3 % Y_2O_3
		4.4		SCF	air	Ref. 2; 3 % Y_2O_3
1.4		17.2		SENB	air	Ref. 3; 2.0 % Y_2O_3; 250 μm nc
1.4		11.2		SENB	air	2.5 %; 93 μm nc
1.3		12.3		SENB	air	3.0 %; 130 μm r
						Ref. 4; 2.6 % Y_2O_3;
		9.5		SENB	air	notch
		5.6		SENB	air	sharp cra
		10.6		SENB	air	Ref. 5; 3 % Y_2O_3
		10.0		SENB	air	Ref. 6; 10 % CeO_2
		8.5		SENB	air	12 %
		4.4		SENB	air	14 %
		4.3		SENB	air	16 %
		4.0		SENB	air	24 %
		3.2		SENB	air	32 %
		2.6		SENB	air	40 %
		2.0		SENB	air	48 %
0.5		8.7		ICS	air	Ref. 7; 8.6 % CeO_2
0.5		6.4		ICS	air	9.5 %
0.5		5.3		ICS	air	10.8 %
0.5		4.9		ICS	air	12.2 %
0.5		4.4		ICS	air	15.8 %
2.5		17.1		ICS	air	8.6 %
2.5		16.9		ICS	air	9.5 %
2.5		12.6		ICS	air	10.8 %
2.5		9.5		ICS	air	12.2 %
2.5		5.8		ICS	air	15.8 %
0.5		23.0		ICS	air	Ref. 8; 12 % CeO_2
0.5		8.0		ICS	air	14 %

0.5	4.0	ICS	air	16 %
1.0	36.0	ICS	air	12 %
1.0	9.0	ICS	air	14 %
1.0	5.0	ICS	air	16 %
0.45	4.7	SENB	air	Ref. 9; V-notch; 3 % Y_2O_3

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Technical inquiries:
Ceramics Division
NIST, 100 Bureau Drive, Stop 8520, Gaithersburg, MD 20899-8520.
Phone (301) 975-6119
Fax (301) 975-5334

Ceramics website comments:
Ceramics Webmaster

General NIST inquiries:
Public Inquiries Unit:
Phone (301) 975-NIST (6478)
TTY (301) 975-8295